8. A process of converting a polymeric silsesquioxane into a POSS nanostructure compound, comprising:

mixing an effective amount of a base with the polymeric silsesquioxane in a solvent to produce a basic reaction mixture, the base reacting with the polymeric silsesquioxane to produce the POSS nanostructure compound,

A18

wherein the polymeric silsesquioxane has the formula $[RSiO_{1.5}]_{\infty}$, and the POSS nanostructure compound is selected from the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, ∞ represents the degree of polymerization and is a number greater than or equal to 1, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure.

SUB B17

9. The process of claim 1, wherein the base and the polymeric silsesquioxane are mixed by stirring the reaction mixture.

10. The process of claim 8, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

11. The process of claim 10, further comprising:

isolating the POSS nanostructure compound.

12. The process of claim 11, wherein the POSS nanostructure compound is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination ~~thereof~~.

SUB B2

13. The process of claim 12, further comprising the step of purifying the isolated POSS nanostructure compound through exhaustive washing with water.

14. The process of claim 8, wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the polymeric silsesquioxane to promote the conversion of the polymeric silsesquioxane into the POSS nanostructure compound.

15. The process of claim 14, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate $[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and RMgX.

16. The process of claim 15, wherein the base is a hydroxide and the concentration of the hydroxide base is between 1-10 equivalents per mole of silicon present in the reaction mixture.

17. The process of claim 16, wherein the concentration of the hydroxide base is between 2-5 equivalents per mole of silicon present in the reaction mixture.

18. The process of claim 8, wherein a mixture of different bases is used.

SUB B3

19. The process of claim 8, further comprises mixing a co-reagent with the base and the polymeric silsesquioxane in the solvent.

20. The process of claim 19, wherein the co-reagent is selected from the group consisting of common Grignard reagents RMgX, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

D

21. The process of claim 8, wherein the solvent is selected from the group consisting of THF, MIK, and toluene.

SUB B4

22. A process of converting a polymeric silsesquioxane into a POSS fragment, comprising:

mixing an effective amount of a base with the polymeric silsesquioxane in a solvent to produce a basic reaction mixture, the base reacting with the polymeric silsesquioxane to produce the POSS fragment,

wherein the polymeric silsesquioxane has the formula $[RSiO_{1.5}]_{\infty}$ and the POSS fragment has the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]$, where R represents an organic substituent, X represents an inorganic substituent, ∞ represents the degree of polymerization and is a number greater than or equal to 1, and m and n represent the stoichiometry of the composition.

23. The process of claim 22, wherein the base and the polymeric silsesquioxane are mixed by stirring the reaction mixture.

24. The process of claim 22, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

25. The process of claim 24, further comprising isolating the POSS fragment.

SUB B5

26. The process of claim 25, wherein the (POSS fragment is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination thereof.

27. The process of claim 26, further comprising the step of purifying the isolated POSS fragment through exhaustive washing with water.

28. The process of claim 22 wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the polymeric silsesquioxane to promote the conversion of the polymeric silsesquioxane into the POSS fragment.

SUB D5

29. The process of claim 28, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate $[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and RMgX.

30. The process of claim 22, wherein a mixture of different bases is used.

SUB B6

31. The process of claim 22, further comprises mixing a co-reagent with the base and the polymeric silsesquioxane in the solvent.

SUB D6

32. The process of claim 31, wherein the co-reagent is selected from the group consisting of common Grignard reagents RMgX, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

SUB B7

33. A process of converting a mixture of different homoleptic POSS nanostructure compounds into a heteroleptic POSS nanostructure compound, comprising:

mixing an effective amount of a base with the mixture of different homoleptic POSS nanostructure compounds in a solvent to produce a basic reaction mixture, the base reacting with the mixture of different homoleptic POSS nanostructure compounds to produce the **(desired)** heterolepic POSS nanostructure compound,

wherein the homoleptic POSS nanostructure compounds have the general formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, and the heteroleptic POSS nanostructure compound is selected from the group consisting of a nonfunctionalized heteroleptic nanostructure compound having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$ and a functionalized heteroleptic nanostructure compound having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure.

34. The process of claim 33, wherein the base and the mixture of different homoleptic POSS nanostructure compounds are mixed by stirring the reaction mixture.

35. The process of claim 33, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

D

36. The process of claim 35, further comprising:

isolating the heterolepic POSS nanostructure compound.

37. The process of claim 36, wherein the heterolepic POSS nanostructure compound is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination thereof.

SUB B8

38. The process of claim 37, further comprising the step of purifying the isolated POSS nanostructure compound through exhaustive washing with water.

39. The process of claim 33, wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the mixture of different homoleptic POSS nanostructure compounds to promote the conversion of the mixture of different homoleptic POSS nanostructure compounds into the heteroleptic POSS nanostructure compound.

D

40. The process of claim 39, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate

$[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and RMgX.

41. The process of claim 40, wherein the base is a hydroxide and the concentration of the hydroxide base is between 1-10 equivalents per mole of silicon present in the reaction mixture.

D

42. The process of claim 41, wherein the concentration of the hydroxide base is between 2-5 equivalents per mole of silicon present in the reaction mixture.

43. The process of claim 33, wherein a mixture of different bases is used.

SUB B9

44. The process of claim 33, further comprises mixing a co-reagent with the base and the mixture of different homoleptic POSS nanostructure compounds in the solvent.

45. The process of claim 44, wherein the co-reagent is selected from the group consisting of common Grignard reagents RMgX, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

D

SUB B10

46. A process of converting a plurality of POSS fragments into a POSS compound, comprising:

mixing an effective amount of a base with the plurality of POSS fragments in a solvent to produce a basic reaction mixture, the base reacting with the POSS fragments to produce the POSS compound,

wherein the POSS fragments have the formula $(RSiO_{1.5})_m(RXSiO_{1.0})_n$, and the POSS compound is selected from the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, and expanded POSS fragments having the formula $(RSiO_{1.5})_m(RXSiO_{1.0})_n$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure.

47. The process of claim 46, wherein the base and the POSS fragments are mixed by stirring the reaction mixture.

48. The process of claim 46, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

49. The process of claim 48, further comprising:

isolating the POSS compound.

50. The process of claim 49 wherein the POSS compound is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination thereof.

SUB B11

51. The process of claim 50, further comprising the step of purifying the isolated POSS compound through exhaustive washing with water.

52. The process of claim 46, wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the POSS fragments to promote the conversion of the POSS fragments into the POSS compound.

SUB D8

53. The process of claim 52, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate $[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and RMgX.

54. The process of claim 53, wherein the concentration of the base is between 1-10 equivalents per mole of silicon present in the reaction mixture.

55. The process of claim 54, wherein the concentration of the hydroxide base is between 1-2 equivalents per mole of silicon present in the reaction mixture.

56. The process of claim 46, wherein a mixture of different bases is used.

SUB B12

57. The process of claim 46, further comprises mixing a co-reagent with the base and the polymeric silsesquioxane in the solvent.

SUB D8

58. The process of claim 47, wherein the co-reagent is selected from the group consisting of common Grignard reagents RMgX, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

SUB B13

59. A process of converting a first functionalized POSS nanostructure compound into a second functionalized POSS nanostructure compound, comprising:

mixing an effective amount of a base with the first functionalized POSS nanostructure compound in a solvent to produce a basic reaction mixture, the base reacting with the first functionalized POSS nanostructure compound to produce the second POSS nanostructure compound,

wherein the first and second POSS nanostructure compounds are each selected from the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure.

60. The process of claim 59, wherein the second functionalized POSS nanostructure compound has more functionalities X than the first functionalized POSS nanostructure compound but the two functionalized POSS nanostructure compounds have the same number of silicon atoms.

61. The process of claim 59, wherein the base and the first functionalized POSS nanostructure compound are mixed by stirring the reaction mixture.

62. The process of claim 61, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

63. The process of claim 62, further comprising:

isolating the second functionalized POSS nanostructure compound.

64. The process of claim 63, wherein the second functionalized POSS nanostructure compound is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination thereof.

SUB B14 65. The process of claim 64, further comprising the step of purifying the isolated POSS nanostructure compound through exhaustive washing with water.

66. The process of claim 59, wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the first functionalized POSS nanostructure compound to promote the conversion of the first functionalized POSS nanostructure compound into the second functionalized POSS nanostructure compound.

SUB D10

67. The process of claim 66, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate $[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and $RMgX$.

68. The process of claim 67, wherein the base is a hydroxide and the concentration of the hydroxide base is between 1-10 equivalents per mole of silicon present in the reaction mixture.

69. The process of claim 68, wherein the concentration of the hydroxide base is between 2-5 equivalents per mole of silicon present in the reaction mixture.

70. The process of claim 59, wherein a mixture of different bases is used.

SUB B15

71. The process of claim 59, further comprises mixing a co-reagent with the base and the polymeric silsesquioxane in the solvent.

SUB D11

72. The process of claim 71, wherein the co-reagent is selected from the group consisting of common Grignard reagents $RMgX$, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

73. A process of converting a POSS fragment and a first POSS nanostructure compound into an expanded second POSS nanostructure compound having a number of silicon Si atoms equal to the combined number of silicon atoms present in the POSS fragment and in the first POSS nanostructure compound, comprising:

mixing an effective amount of a base with the POSS fragment and the first POSS nanostructure compound in a solvent to produce a basic reaction mixture, the base reacting with the POSS fragment and the first POSS nanostructure compound to produce the expanded second POSS nanostructure compound,

SUB B16

wherein the first and second POSS nanostructure compounds are each selected from the group consisting of. homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, and silicate nanostructure compounds having the formula $[(XSiO_{1.5})_n]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure

74. The process of claim 73, wherein the base, the POSS fragment and the first POSS nanostructure compound are mixed by stirring the reaction mixture.

75. The process of claim 73, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

76. The process of claim 74, further comprising:

isolating the expanded second POSS nanostructure compound.

77. The process of claim 76, wherein the expanded second POSS nanostructure compound is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination thereof.

SUB B17

78. The process of claim 77, further comprising the step of purifying the isolated POSS nanostructure compound through exhaustive washing with water.

79. The process of claim 78, wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the first POSS nanostructure compound to promote the conversion of the polymeric silsesquioxane into the expanded second POSS nanostructure compound.

80. The process of claim 79, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate $[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and RMgX.

81. The process of claim 80, wherein the base is a hydroxide and the concentration of the hydroxide base is between 1-10 equivalents per mole of silicon present in the reaction mixture.

82. The process of claim 81, wherein the concentration of the hydroxide base is between 2-5 equivalents per mole of silicon present in the reaction mixture.

D

83. The process of claim 73, wherein a mixture of different bases is used.

SUB B18

84. The process of claim 73, further comprises mixing a co-reagent with the base and the polymeric silsesquioxane in the solvent.

85. The process of claim 84, wherein the co-reagent is selected from the group consisting of common Grignard reagents RMgX, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

86. A process of converting an unfunctionalized POSS nanostructure compound into a functionalized POSS nanostructure compound, comprising:

SUB B19

mixing an effective amount of a base with the unfunctionalized POSS nanostructure compound in a solvent to produce a basic reaction mixture, the base reacting with the unfunctionalized POSS nanostructure compound to produce the functionalized POSS nanostructure compound,

wherein the unfunctionalized POSS nanostructure compound is selected from the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$ and heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, and the functionalized POSS nanostructure compound is selected from the group consisting of functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$ and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of

the composition, $\sum$ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure.

87. The process of claim 86, wherein the base and the unfunctionalized POSS nanostructure compound are mixed by stirring the reaction mixture.

88. The process of claim 86, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

89. The process of claim 88, further comprising:

isolating the functionalized POSS nanostructure compound.

90. The process of claim 89, wherein the functionalized POSS nanostructure compound is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination thereof.

SUB B28 91. The process of claim 90, further comprising the step of purifying the isolated functionalized POSS nanostructure compound through exhaustive washing with water.

92. The process of claim 86, wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the unfunctionalized POSS nanostructure compound to promote the conversion of the polymeric silsesquioxane into the functionalized POSS nanostructure compound.

93. The process of claim 92, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate $[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and RMgX.

SUB D13

94. The process of claim 93, wherein the base is a hydroxide and the concentration of the hydroxide base is between 1-10 equivalents per mole of silicon present in the reaction mixture.

95. The process of claim 94, wherein the concentration of the hydroxide base is between 2-5 equivalents per mole of silicon present in the reaction mixture.

96. The process of claim 95, wherein a mixture of different bases is used.

SUB B21

97. The process of claim 86, further comprises mixing a co-reagent with the base and the polymeric silsesquioxane in the solvent.

SUB D14

98. The process of claim 97, wherein the co-reagent is selected from the group consisting of common Grignard reagents RMgX, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

99. A process of rearranging the structure of a compound selected from the group consisting of POSS fragments having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]$, silicate nanostructure compounds having the formula $[(XSiO_{1.5})_n]_{\Sigma\#}$, homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, the process comprising:

SUB B22

mixing an effective amount of a base with the compound in a solvent to produce a basic reaction mixture,

where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure.

100. The process of claim 99, wherein the structure of the compound is rearranged so that the compound is converted into another compound selected from the group.

101. The process of claim 99, wherein the structure of the compound is rearranged so that the compound is cleaved into a plurality of smaller compounds selected from the group.

102. The process of claim 99, wherein the base and the compound are mixed by stirring the reaction mixture.

103. The process of claim 99, further comprising the steps of:

heating the reaction mixture to reflux; and

cooling the reaction mixture to room temperature.

104. The process of claim 103, further comprising:

isolating the compound.

105. The process of claim 104, wherein the compound is isolated by distillation, filtration, evaporation, decantation, crystallization, pressure reduction, or extraction, or a combination thereof.

106. The process of claim 105, further comprising the step of purifying the compound through exhaustive washing with water.

107. The process of claim 99, wherein the base cleaves at least one silicon-oxygen-silicon (Si-O-Si) bond in the compound.

108. The process ~~of claim~~ 107, wherein the base is selected from the group consisting of hydroxide $[OH]^-$, organic alkoxides $[RO]^-$, carboxylates $[RCOO]^-$, amides $[RNH]^-$, carboxamides $[RC(O)NR]^-$, carbanions $[R]^-$ carbonate $[CO_3]^{-2}$, sulfate $[SO_4]^{-2}$, phosphate $[PO_4]^{-3}$, biphosphate $[HPO_4]^{-2}$, phosphourus ylides $[R_4P]^-$, nitrate $[NO_3]^-$, borate $[B(OH)_4]^-$, cyanate $[OCN]^-$, fluoride $[F]^-$, hypochlorite $[OCl]^-$, silicate $[SiO_4]^{-4}$, stannate $[SnO_4]^{-4}$, basic metal oxides comprising Al_2O_3, CaO, and ZnO, amines R_3N and amine oxides R_3NO, and organomtallics comprising RLi, R_2Zn, R_2Mg, and RMgX.

109. The process of claim 108, wherein the base is a hydroxide and the concentration of the hydroxide base is between 1-10 equivalents per mole of silicon present in the reaction mixture.

110. The process of claim 109, wherein the concentration of the hydroxide base is between 2-5 equivalents per mole of silicon present in the reaction mixture.

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111. The process of claim 110, wherein a mixture of different bases is used.

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112. The process of claim 99, further comprises mixing a co-reagent with the base and the polymeric silsesquioxane in the solvent.

113. The process of claim 112, wherein the co-reagent is selected from the group consisting of common Grignard reagents RMgX, alkalihalides, zinc compounds comprising ZnI_2, $ZnBr_2$, $ZnCl_2$, and ZnF_2, aluminum compounds comprising Al_2H_6, $LiAlH_4$, AlI_3, $AlBr_3$, $AlCl_3$, and AlF_3, and boron compounds comprising $RB(OH)_2$, BI_3, BBr_3, BCl_3, and BF_3.

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114. The process of claim 8, wherein the POSS nanostructure compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

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115. The process of claim 46, wherein the POSS compound is $[108SiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

116. The process of claim 59, wherein the second functionalized POSS nanostructure compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

117. The process of claim 73, wherein the expanded second POSS nanostructure compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

118. The process of claim 86, wherein the functionalized POSS nanostructure compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

119. The process of claim 99, wherein the functionalized POSS nanostructure compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

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120. A compound comprising a member of the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma \#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma \#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma \#}$, and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma \#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, ∞represents the degree of polymerization and is a number greater than or equal to 1, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure, wherein the compound is produced by the process of claim 8.

121. A compound as recited in claim 120, wherein the compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

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122. A compound produced by the process of claim 22, the compound having the formula $[RSiO_{1.5})_m(RXSiO_{1.0})_n]$, where R represents an organic substituent, X represents an inorganic substituent, and m and n represent the stoichiometry of the composition.

123. A compound comprising a member of the group consisting of nonfunctionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma \#}$ and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma \#}$, where R and R' each represents an organic substituent,

X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure, wherein the compound is produced by the process of claim 33.

124. A compound comprising a member of the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, and expanded POSS fragments having the formula $(RSiO_{1.5})_m(RXSiO_{1.0})_n$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure, wherein the compound is produced by the process of claim 46.

125. A compound as recited in claim 124, wherein the compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma7}$.

126. A compound comprising a member of the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure, wherein the compound is produced by the process of claim 59.

127. A compound as recited in claim 126, wherein the compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

128. A compound comprising a member of the group consisting of homoleptic nanostructure compounds having the formula $[(RXSiO_{1.5})_n]_{\Sigma\#}$, heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n]_{\Sigma\#}$, functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$, functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, and silicate nanostructure compounds having the formula $[(XSiO_{1.5})_n]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure, wherein the compound is produced by the process of claim 73.

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129. A compound as recited in claim 128, wherein the compound is $[(RSiO_{1.5})_4(RXSiO_{1.0})_3]_{\Sigma 7}$.

130. A compound comprising a member of the group consisting of functionalized POSS nanostructure compound is selected from the group consisting of functionalized homoleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(RXSiO_{1.0})_n]_{\Sigma\#}$ and functionalized heteroleptic nanostructure compounds having the formula $[(RSiO_{1.5})_m(R'SiO_{1.5})_n(RXSiO_{1.0})p]_{\Sigma\#}$, where R and R' each represents an organic substituent, X represents an inorganic substituent, m, n and p represent the stoichiometry of the composition, Σ indicates nanostructure, and # represents the number of silicon atoms contained within the nanostructure, wherein the compound is produced by the process of claim 86.